IMPRESSIONS OF ENGLISH SEWAGE DISPOSAL PRACTICE

PAUL HANSEN, OF PEARSE, GREELEY & HANSEN, ENGINEERS, CHICAGO

During the summer of 1924 the writer visited England, attended an international conference of sanitary engineers, visited a number of sewage treatment works and gained certain impressions regarding British sewage treatment practice. It is the purpose of this paper to set down some of those impressions without any attempt to go into deeply technical matters.

The conference of sanitary engineers afforded an especially good opportunity to observe habits and tendencies of thought among British engineers on the subject of sewage disposal. Practically all papers and discussions were upon some phase of the activated sludge process. Sprinkling filters were hardly mentioned and as might be supposed little attention was given to the older processes excepting as these came up incidentally. It was quite obvious that activated sludge, or as they prefer to call it, bio-aeration is the accepted process of the day, though a few engineers, and among them some of the best informed and more conservative minded, in private conversation expressed their belief that sprinkling filters are by no means obsolete.

Curiously enough, very little was said in the public discussion to justify activated sludge on the grounds of ultimate economy. The fact that installation costs are much cheaper than for any other process seemed to constitute the weighty consideration in favor of activated sludge. The unemployed situation as well as the general financial situation then prevailing may have had something to do with this attitude. It was and probably still is difficult to obtain money for installation costs, but it is relatively easy to obtain appropriations for labor for maintaining public works due to efforts to assist the unemployed.

The main cleavage of thought was over the relative merits of aeration by mechanical means such as paddles and propellers and aeration by means of diffused air. The two schools that have developed out of this con-

troversy, and it impresses one more as a controversy than a genuine seeking after truth, are quite confident of the correctness of their respective positions and are inclined to claim everything and admit nothing. It is difficult to say which method of aeration has the greater support but the school in favor of mechanical agitation is gaining many adherents.

The process of bio-aeration is still so much in the developmental stage that it was difficult to obtain convincing evidence in favor of either diffused air or mechanical aeration, and the proponents of each method in private conversation were quite free in stating what the other method could not accomplish and what they were quite sure could be accomplished by the methods advocated by them.

The proponents of diffused air claim in general that aeration by agitation takes up a great deal of space because of shallow depths required in the aerating tanks, that relatively costly construction is involved, that long aeration periods are necessary and that at least thirty horse-power hours are required to treat one million Imperial gallons of sewage. For diffused air they claim the advantage of deep tanks and hence low construction costs, simplicity of operation, more perfect control of process, low power demand not exceeding 25 horse power hours per million Imperial gallons, and a probability of cutting power demands down to 15 horse power hours through improvement in details. Typical of such possible improvements is cited the "Manchester Bottom", an arrangement of porus diffusion plates along one side of the aerating channels which produce a helicoidal motion of the sewage along the length of the channels and which results in a very definite economy of air. They also cite improvements in air compressors and are now trying out a reciprocating type, not yet perfected, which is expected to show greater efficiencies than the rotating types common in America.

The proponents of mechanical agitation claim light construction involving simple form work or merely low thin brick walls, and point out that old contact beds can readily be utilized thus saving very materially in construction costs. They also claim low power require-

ments not exceeding 25 horse power hours per million Imperial gallons, and with improved large scale works they expect to reduce the power requirements to at least 15 horse power hours. Diffused air they maintain is uneconomical, requiring 40 to 60 horse power hours per million Imperial gallons, is complicated and subject to derangements on account of leaky air pipes, clogged diffusion plates, etc.

Generally speaking, it was difficult to obtain analytical and cost data that would permit a reliable comparison of performances at different installations, though probably a more persistent effort, if time had permitted, might have resulted in obtaining a little more comparative data. The general tendency is to compare sewage on the basis of oxygen consumed using different procedures in different laboratories. This method is at best an indifferent measure of the strength of sewage and different procedures give widely varying results.

All that can be said is that both diffused aeration and mechanical aeration have merits, the visible results obtained by both methods are impressive, and they are sufficiently close together in point of economy to deserve careful consideration by the engineer who is called upon to design work.

There is also a cleavage among the proponents of mechanical agitation, one group favoring a paddle wheel type of agitation with very shallow aerating channels as developed by Haworth at Sheffield, the other group favoring a propeller type rotating on a vertical shaft at the surface of a relatively deep tank. This latter device is patented and known as the Simplex, and is manufactured by Ames and Crosta. The Sheffield system is not patented, as Haworth is strongly opposed on principle to professional engineers taking out patents on anything they may design. Haworth's view does not seem to be a view generally held by British engineers.

While the sludge disposal problem in connection with activated sludge is by no means ignored in England, it is not given anything like the emphasis given it in this country. Much has been said and is being said about the high fertilizer value of activated sludge but actually no activated sludge has been dewatered and marketed

on a commercial scale, and as in this country economical methods are only a prospect and not an accomplishment. The experiments and studies on dewatering activated sludge carried out by the Chicago Sanitary District and by the Milwaukee Sewage Commission are far more complete, thorough and on a larger scale than anything that has been done in England.

At most English plants, sewage receives more or less prolonged sedimentation either in detritus tanks or sedimentation basins and excess activated sludge is mixed with the more or less septic sludge from these devises and applied to land or drying beds. In some instances a market is developed for this material but at a very low price, while at others it is either plowed into the ground or removed and dumped.

Contrasted with American practice, British engineers are inclined to build large scale experimental plants of such permanent construction that they may become a part of the ultimate works if they prove successful. The only comparable installation in this country is the Desplaines River plant of the Chicago Sanitary District which is of permanent construction but of such flexible arrangement as to constitute in effect an experimental plant, but even this plant was preceded by very careful and extensive experiments in temporary wooden structures on a relatively small and cheap scale, yet on a scale distinctly larger than might be termed a laboratory scale and large enough to give reliable indications.

In English sewage treatment practice there is to American eyes a curious mixture of antiquated devices and bold novelties, the psychology of which is a little difficult to explain. In a number of plants sedimentation tanks and contact beds built over a quarter of a century ago, types long since abandoned in this country in the larger works, are still in regular and reasonably effective operation, while alongside are bio-aeration plants of a type that no American engineer has yet dared to build on more than a small experimental scale.

The most plausible explanation is about as follows: The prevailing habit in the older and more densely populated European countries is to build well and for permanence. There is also the habit of careful main-

tenance and upkeep observable in every detail of life. So it is with sewage treatment works; once built they are maintained and operated with most conscientious care until their lack of economy in comparison with more modern methods absolutely forces a change. Even when changes are made, preference is given to new methods which permit a maximum utilization of old structures, thereby bringing about novel arrangements, as witness the adaptation of old contact beds by Haworth at Sheffield to the activated sludge process. Furthermore, a skill in the manipulation of the older devices, especially settling basins and detritus tanks, under conditions obtaining locally causes the operators to actually prefer these devices to new arrangements.

The desire to use existing structures only partially accounts for the boldness with which novelties are installed. Perhaps the success of British operating engineers in getting results out of whatever they happen to have gives them confidence in the success of whatever they may install. Another thought is that because of low water consumption and consequent low sewage flow amounting to $\frac{1}{3}$ to $\frac{1}{2}$ of the flow usually obtained in the United States, the works after all are not great as compared with our standards, and the full size test installations which treat one-half million to a million Imperial gallons are not so very large or costly though they may constitute a relatively large proportion of the total treating capacity. Certainly England wastes far less in rash construction than we waste in unnecessary neglect and abandonment of sewage treatment works.

Another significant feature of English sewage disposal practice is the prevailing acceptance of the necessity of keeping the streams of the country clean. England has gotten well beyond the point where sewage treatment works are built and operated as a result of coersion by injured riparian owners. It is now done with the same willingness and matter-of-factness exhibited by the conscientious householder who wants his back yard as clean as his front yard. Sewage disposal departments are well ordered, well manned and stable, quite on a par with the water department or any other department operating a municipal utility.

By way of illustrating the foregoing general remarks, very brief description will be given of a few plants visited.

At Eastham, in the London District, there is an experimental bio-aeration plant having a capacity of about one-half million Imperial gallons designed along the lines of Haworth's installation at Sheffield. The sewage first receives a rough screening in the sewer, by means of a mechanically cleaned screen placed in the sewer. Sewage is pumped from the sewer into detritus tanks having a retention period of about twenty-four hours. These tanks are shown in Fig. 1, one of them being empty. These tanks are typical, though most of the more recent detritus tanks are built with hopper bottoms.

From the detritus tanks the sewage flows into the aerating channels, as shown in Fig. 2.

A current is induced in these channels by means of paddle wheels resembling somewhat the paddles of side wheel steamboats. The housings of these paddles are shown in the distance in Fig. 2. There is introduced with the sewage into these channels a proper proportion of activated sludge amounting to about 20 to 25 per cent of the volume of the sewage. The operation of this arrangement is more or less analogous to the self purification that takes place in a flowing stream. The total travel of the water is something like 3000 ft. The current is maintained by the paddle wheels and the paddles also induce a wave action which is regarded as very important in exposing new surfaces to contact with the atmosphere. The process of purification is thus maintained on an aerabic basis and is greatly accelerated by the presence of activated sludge. Fig. 3 shows the ends of some of the channels; the dark matter adhering to the walls gives a good indication of the magnitude of the wave action. At the remote end from the inlet the mixed sewage and sludge is drawn off into sedimentation tanks of the hopper type.

A glimpse of these sedimentation tanks, including the final outlet, is shown in Fig. 4.

Note that the outlet channel is lined with white enameled bricks and kept very clean. This affords a very practical means of observing the condition of the effluent.

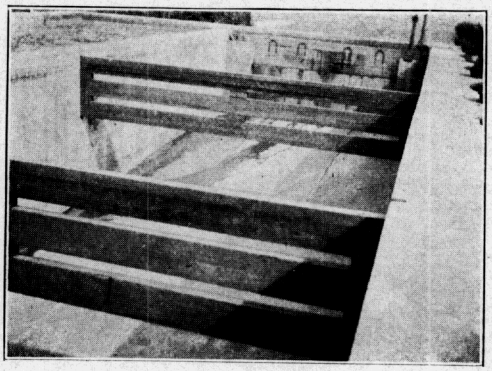

Fig. 1.

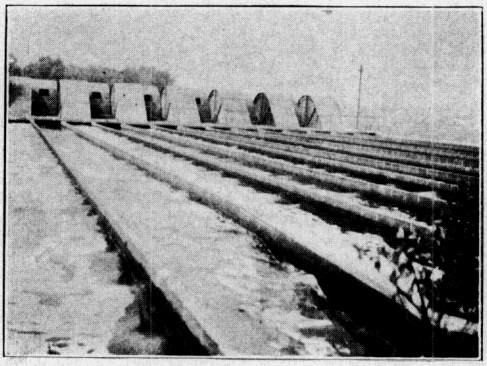

Fig. 2.

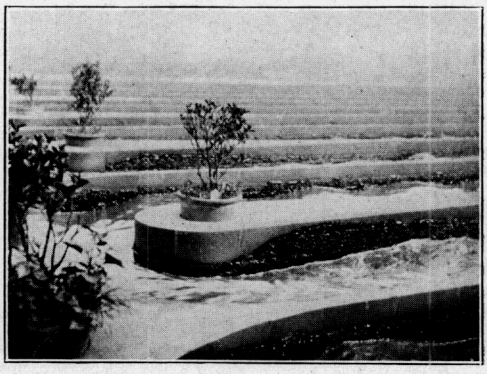

Fig. 3.

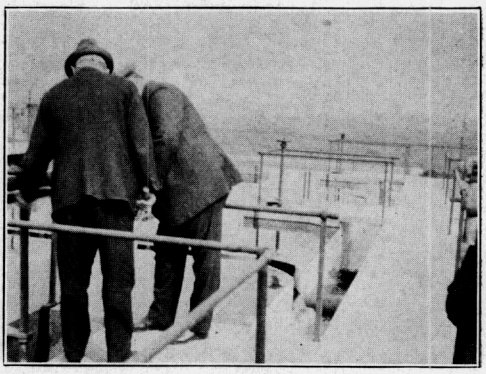

Fig. 4.

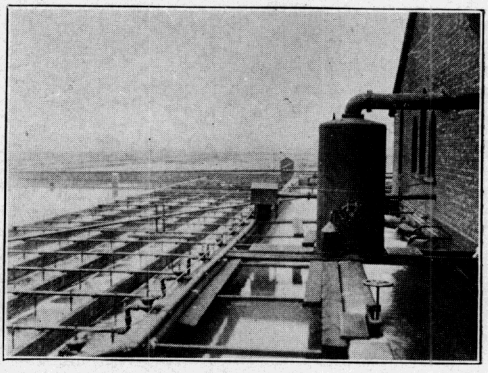

Fig. 6.

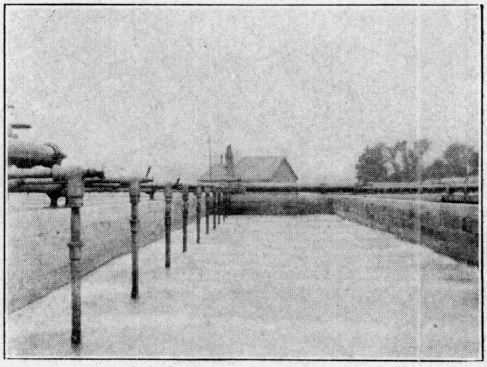

Fig. 7.

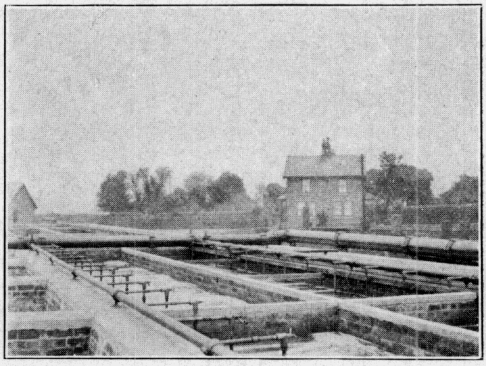

Fig. 8.

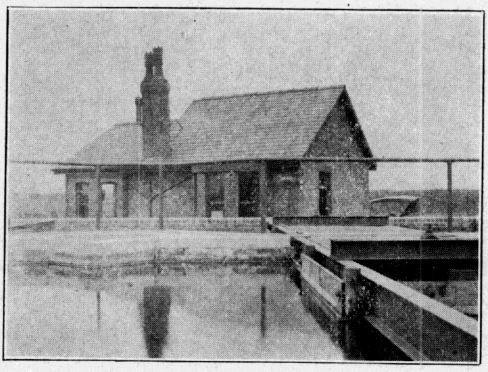

Fig. 9.

In passing, it may be noted that the treatment at the Eastham Works comprises chemical precipitation, sprinkling filters and final sedimentation tanks. The chemicals used are lime and sulphate of iron. The sprinkling filters are built of cinders and are over twenty years old. While not in the best of condition they still give reasonably good results. It is because the filters are operated beyond their capacity that new methods are now being considered. The filter effluent goes to a large final sedimentation basin and is discharged on the outflow of the tide into the Thames River. Notwithstanding the age and relative inefficiency of the older works they are still operated and maintained with scrupulous care. The grounds about are planted beautifully with flowers and shrubbery, and constitute a model of good general maintenance.

At Manchester there is still in operation the first continuous flow activated sludge plant, shown in Fig. 6.

Fig. 7 gives a good impression of the effect of the Manchester bottoms in inducing crosswise currents. The air is introduced at the bottom of the tanks on the left which causes the water to rise on the left and then travel to the opposite side of the tank on the right.

A new plant has recently been installed at the Withington Works at Manchester, which is shown in Fig. 8.

This plant is very similar to the original plant excepting that numerous transverse baffles are placed in the aerating channels with a view to inducing more effective displacement. There is but a small opening in each baffle near the bottom on the side opposite from that on which air is introduced. A glimpse of the final sedimentation basin, which receives the sewage and sludge from the aeration channels, is shown in Fig. 9.

At Reading there is an activated sludge plant of the diffusion type under construction. The notable feature of this plant is the very great depth of the aerating tanks, namely, 22 feet. Fig. 10 shows one of these aerating tanks partially completed. From the structural point of view this plant is also interesting. Gravity walls of very great thickness, namely, about 7 feet are used. The

exteriors of these walls are made of brick. The bricks are carried up a few courses at a time and serve as forms for the mass concrete within the walls. Some idea of the character of these walls can be obtained from Fig. 10.

The inside of one of the final sedimentation tanks at Reading is shown in Fig. 11. These tanks contain what is known as the "Clifford Inlet", a device which prevents the sewage from rushing to the bottom of the tank and disturbing the sludge. This inlet consists simply of a pipe discharging into a bucket, as shown in Fig. 11. Surrounding the pipe and bucket is placed a baffle arrangement which is not shown in the Figure. This baffle permits the liquid to flow gently downward to about mid-depth of the tank and then laterally upward and out over the outlet weirs.

At Birmingham there is an interesting experimental development comprising the use of bio-aeration as a preliminary treatment to sprinkling filters. It is stated that this preliminary treatment increases the population loading that can be placed on the sprinkling filters from 20,000 persons per acre to 60,000 persons per acre. The period of aeration is short, only about one hour. The volume of sludge used in contact with the sewage is also very small, not exceeding seven per cent. The theory of the process is shown graphically in Fig. 12.

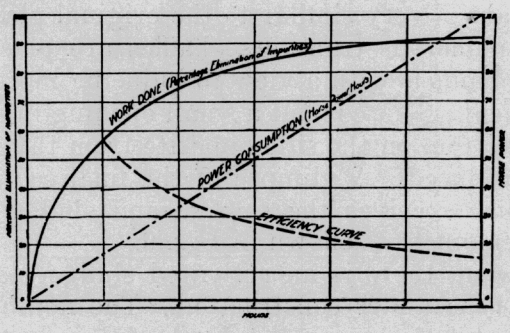

Fig. 12.

This chart shows that after one hour's operation the efficiency curve falls off rapidly. Accordingly the Engineers of the Birmingham Tame & Rea District reasoned

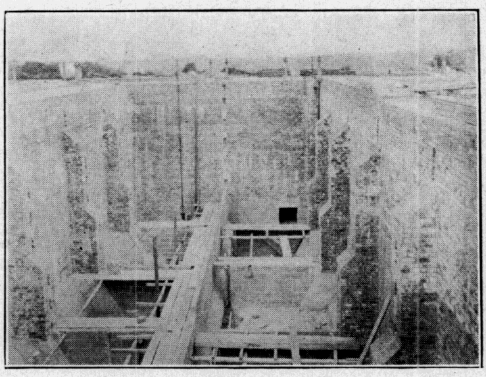

Fig. 10.

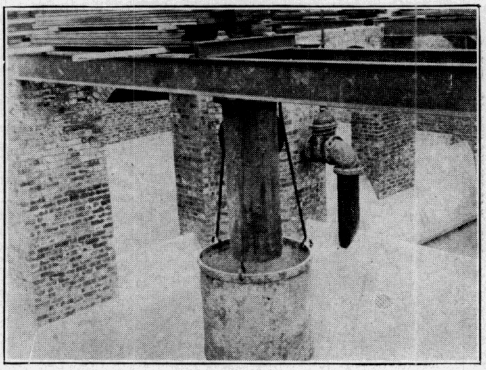

Fig. 11.

that a short period would obtain the maximum results with minimum economy. Because the process is not carried to completion the sludge is reaerated for a considerable length of time, at least six hours.

The general plan of a complete unit for a preaeration plant is shown in Fig. 13, and a longitudinal section as

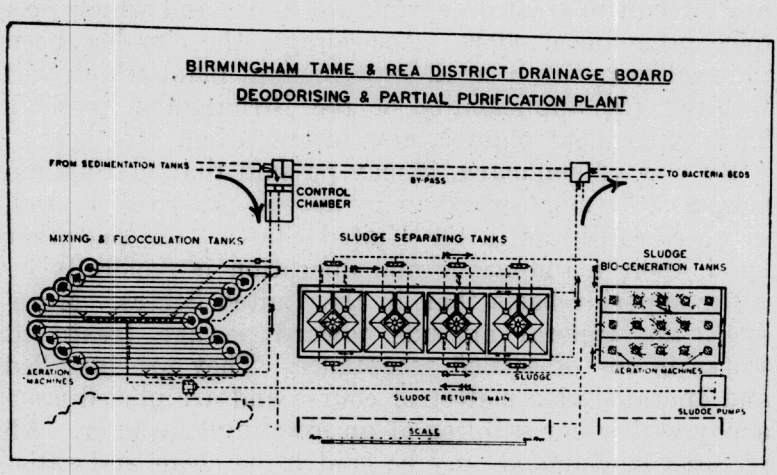

Fig. 13.

shown in Fig. 14. At the present time, only a portion of this unit has been built.

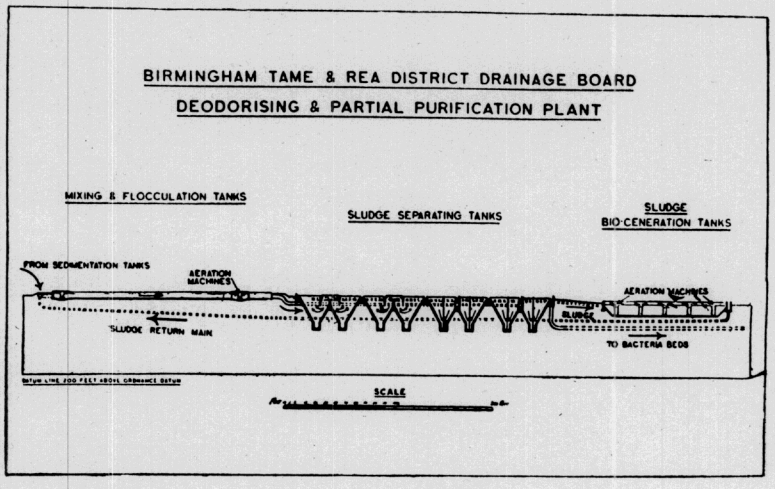

Fig. 14.

This combination of treatment, namely, preliminary treatment with activated sludge and subsequent treatment on sprinkling filters, seems to be well adapted to peculiar local conditions at Decatur, Illinois. The factor at Decatur which makes the conditions unusual is the presence of a large volume of corn products wastes which are difficult to treat on sprinkling filters and which produce pronounced odors. Accordingly the city has been induced to put in a small experimental plant which will test out the applicability of the Birmingham method. This experiment plant is now in operation.

By way of summary, it may be said that in England sewage treatment works may not be designed so well or so carefully as in the United States. On the other hand, their maintenance and operation is generally on a far superior basis than in the United States. Moreover, the general attitude toward sewage treatment works is one of settled acceptance. They are installed and operated as a matter of course and are placed upon a par with other utilities of an exacting character. All streams in England may be said to be clean and satisfactory for the use to which they may be put.